

AUTOMATED KEYBOARD MOUSE SWITCH

## BACKGROUND OF THE INVENTION

## 5        1.    Technical Field:

10        The present invention generally relates to improved concurrent use of multiple data processing systems and in particular to improved concurrent use of a single set of input devices (keyboard, mouse, etc.) enabling a user to interact with multiple data processing systems. Still more particularly, the present invention relates to an automatic keyboard/mouse switch enabling a single set of input devices to be employed by a user in interacting with multiple data processing systems without manual switching.

## 20        2.    Description of the Related Art:

25        Many data processing system users require the simultaneous use of multiple data processing systems, each system having a separate display and operating either separately from the remaining data processing systems or collaboratively as part of distributed system. For example, financial traders often need to be able to view and control several different systems at the same time in order to both receive required information from multiple sources and to concurrently make trades. Multiple systems are also frequently required for other reasons, such as where each

workstation performs a dedicated function, redundancy is desired, etc.

Of course, user work space limitations or other practical considerations often preclude or inhibit the use of separate sets of input devices (such as a keyboard and mouse or other pointing device) for each of several data processing systems being concurrently employed by the user. Instead, a single set of input devices shared and switched between the multiple data processing systems is preferable. The current means for sharing input devices between multiple data processing systems generally requires the user to manually switch between the different data processing systems, either by operating a physical switch or entering a predefined keystroke sequence. Using a manual switch, the user can select the "active" data processing system (i.e., the data processing system to which user input through the keyboard or mouse is transmitted) by turning the switch to the appropriate position. Similarly, entry of a specific keystroke sequence allows the user to change the active system by signaling to the multiple systems that the change in active systems is desired.

All of the current solutions, however, require that the user interrupt the current task in order to manually perform the switch between multiple data processing systems. It would be desirable to provide a system, method, and computer program product which would allow the user to dynamically switch the active data processing system while continuing to work, and in the most unobtrusive manner possible.

## SUMMARY OF THE INVENTION

It is therefore one object of the present invention to provide improved concurrent use of multiple data processing systems.

It is another object of the present invention to provide improved concurrent use of a single set of input devices (keyboard, mouse, etc.) enabling a user to interact with multiple data processing systems.

It is yet another object of the present invention to provide an automatic keyboard/mouse switch enabling a single set of input devices to be employed by a user in interacting with multiple data processing systems without manual switching.

The foregoing objects are achieved as is now described. A single set of input devices (keyboard, mouse, etc.) is employed with a plurality of data processing systems each having a separate display. The logical display areas for the displays are arranged in a contiguous array to have common boundaries, with an edge (e.g., a right boundary or a lower boundary) of one logical display area coinciding with an edge of another logical display area (e.g., a left boundary or an upper boundary). When a cursor controlled by a pointing device is moved past a logical display area boundary which the current active data processing system shares in common with another data processing system, the active data processing system to which input device signals

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are transmitted is automatically switched to the other data processing system. No manual switching or hot-key sequence by the user is required, and the active data processing system may be automatically switch among any of a number of data processing systems simply by moving the cursor across logical display area boundaries between the data processing systems.

The above as well as additional objectives, features, and advantages of the present invention will become apparent in the following detailed written description.

## BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself however, as well as a preferred mode of use, further objects and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

**Figure 1** depicts a set of data processing systems in accordance with a preferred embodiment of the present invention;

**Figure 2** is a diagram of the logical arrangement of data processing system logical display areas for a set of data processing systems employing automated input device switching in accordance with a preferred embodiment of the present invention; and

**Figure 3** depicts a high level flow chart for a process of automatically switching input devices between data processing systems in accordance with a preferred embodiment of the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference now to the figures, and in particular with reference to **Figure 1**, a set of data processing systems in accordance with a preferred embodiment of the present invention are depicted. Data processing system group **102** includes  $n$  data processing systems **104a-104n**, where " $n$ " is any positive integer. Each data processing system **104a-104n** is complete, with the potential exception of user input devices, and may operate independently of or cooperatively with the remaining data processing systems. Each data processing system **104a-104n** has a separate display.

A single set of user input devices **106** may be employed by a user to interact with any of the data processing systems **104a-104n**. User input devices **106** include at least a pointing device such as a mouse, trackball or the like, and preferably also include a keyboard. User input devices **106** may optionally include, for example, a microphone, a video camera, etc. User input devices **106** are coupled to data processing systems **104a-104n** via an input controller and switch **106**, which operates as described in further detail below to automatically select an "active" data processing system. According to the preferred embodiment, the input devices **106** are preferably all Universal Serial Bus (USB) devices, and the input controller/switch **108** is connected to each data processing system **104a-104n** via a USB port on each system.

Referring to **Figure 2**, a diagram of the logical arrangement of data processing system logical display areas for a set of data processing systems employing automated input device switching in accordance with a preferred embodiment of the present invention is illustrated. In the example shown only four display areas are illustrated, although the present invention may be extended to include any number of display areas.

In the example shown, the logical arrangement **202** of display areas **204a-204n**, which correspond on a one-to-one basis to data processing systems **104a-104n**, is a checker-board pattern, or an array of contiguous display areas having two rows and two columns. Other logical arrangements, such as larger sized arrays or a single linear row of display areas, may also be utilized with the present invention. Preferably, although not necessarily, the selected logical arrangement of logical display areas **204a-204n** corresponds--at least with respect to positional relationships, although intermediate spacings may vary--to the physical arrangement of the actual, physical displays for data processing systems **104a-104n**. That is, the logical arrangement **202** of display areas **204a-204n** corresponds to a physical placement of the displays for data processing systems **104a-104n** in a similar positional relationship (i.e., the display for data processing system **104a** above the display for data processing system **104c** and to the left of the display for data processing system **104b**, etc.).

As known in the art, each display area **204a-204n** has a logical size and includes an array or mapping of pixels which make up the display area. A pointing device or mouse employs pixel locations or coordinates for pixels within the array to define the position of the cursor within the logical display area. Movement of the pointing device results in the coordinates of the cursor changing, and corresponding movement of the position of the cursor within the display area.

Display areas **204a-204n** are logical display areas, which typically occupy slightly less than the physical display area of the actual data processing system display. Logical display areas **204a-204n** define the boundaries of the content displayed to the user on the display, with content falling outside the boundaries being suppressed or simply not displayed. In most conventional data processing systems, cursor movement within the logical display area is permitted up to but not beyond the boundaries.

In the present invention, display areas **204a-204n** are logically arranged to have "common" boundaries. That is, the right boundary (as viewed) for display area **204a** coincides with the left boundary for display area **204b**; the lower boundary for display area **204a** coincides with the upper boundary for display area **204c**; the lower boundary for display area **204b** coincides with the upper boundary for display area **204n**; and the right boundary for display area **204c** coincides with the left boundary for display area **204n**.



These "common" boundaries are treated as switch points between active systems.

5 Rather than suppressing or preventing cursor movement past a boundary of a display area **204a-204n** which forms part of a "common" boundary, movement of the cursor **206** across a "common" boundary triggers an automatic switching of the input devices **106** from one data processing system **104a-104n** corresponding to the display area in which the cursor  
10 originally started to another data processing system **104a-104n** corresponding to the display into which the cursor crossed over.

For example, when data processing system **104a**,  
15 corresponding to display area **204a**, is initially the "active" data processing system to which signals from input devices **106** are routed and the cursor **206** is moved by the user across common boundary **208a** from display areas **204a** into display area **204b**, the "active" data processing system  
20 is automatically switched to data processing system **104b**, corresponding to display area **204b**, and signals from input devices **106** are then routed to data processing system **104b** until the cursor again crosses a common boundary between display areas.

25 Similarly, if the cursor **206** is moved by the user across common boundaries **208c** and **208d**, the active data processing system automatically switches, first to data processing system **104n** corresponding to display area **204n**

and then to data processing system **104c** corresponding to display area **204c**. The process is also bidirectional. If the cursor **216** were initially in display area **204b** and was moved by the user past common boundary **208a** into display area **204a**, the active data processing system would automatically switch from data processing system **104b**, corresponding to display area **204b**, to data processing system **104a**, corresponding to display area **204a**. The user may thus automatically switch between active data processing systems, without use of a manual switch or hot-key sequence, by simply manipulating a pointing device to move the cursor across a logical common boundary between two data processing systems.

Automatic switching of the "active" data processing system when the cursor crosses a common logical boundary between display areas may be accomplished in a number of different manners. The current active data processing system may detect movement of the cursor past a logical display area boundary which is common with the display area for another data processing system, and signal input controller/switch **108** via the USB bus to switch to a different data processing system identified within the switch request. Alternatively, input controller/switch **108** may be calibrated, in terms of the number of mouse events and display coordinates, to detect crossings of common boundaries between data processing systems. Input controller/switch **108** may then automatically switch the

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active data processing system upon detecting a common boundary for two logical display areas being crossed.

Locations within logical display areas **204a-204n**, including the location of cursor **206**, is normally defined by X, Y coordinates, with a zero X coordinate and a maximum X coordinate defining two boundaries of the logical display area and a zero Y coordinate and a maximum Y coordinate defining the other two boundaries. In the present invention, the maximum X coordinate of one display area (e.g., display area **204a**) may be treated as logically equal to the zero X coordinate of another, adjoining display area (e.g., display area **204b**), and similarly the zero Y coordinate of a display area (e.g., display area **204a**) may be treated as logically equal to the maximum Y coordinate of another, adjoining display area (e.g., display area **204c**).

When the X, Y coordinates of the cursor location change with the X coordinate exceeding the maximum X coordinate of the first display area or with the Y coordinate dropping below the zero Y coordinate for the first display area, the cursor location may be treated as exceeding the zero X coordinate or falling below the maximum Y coordinate of the adjoining display area by an equal amount. Following automatic switching of the input devices **106** to the corresponding data processing system, the cursor may be displayed within the adjoining display area at a location which is a distance past the zero or maximum X coordinate and/or the zero or maximum Y coordinate which corresponds to

the number of mouse events (coordinate changes) generated by the pointing device after the common boundary was reached.

Although the example shown involves only four logical display areas/data processing systems, with each logical display area having two boundaries in common with other logical display areas, the present invention may be readily extended to any number of display areas and data processing systems in any desired configuration, with as many as all four boundaries for some logical display areas being in common with other logical display areas. For instance, the array 202 depicted in **Figure 2** could be extended to a 3X3 array of nine data processing systems/logical display areas, with the center logical display area having common boundaries on all four sides. Alternatively, the array 202 in **Figure 2** could be changed to a 1X4 array, or a single row of logical display areas.

With reference now to **Figure 3**, a high level flow chart for a process of automatically switching input devices between data processing systems in accordance with a preferred embodiment of the present invention is depicted. The process begins at step 302, which depicts detection of cursor movement within the display area of an active data processing system receiving input signals from a set of common input devices shared by multiple data processing systems. The process first passes to step 304, which illustrates a determination of whether a boundary for the display area of the active data processing was crossed by

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movement of the cursor. If not the process proceeds to step 306, which depicts updating the cursor location within the display area of the active data processing system, which will result in updating the display image of the cursor within the display area.

If movement of the cursor causes the cursor location to cross a boundary (i.e., pass a zero or maximum X or Y coordinate), the process then proceeds instead to step 308, which illustrates a determination of whether the cursor movement crosses a common boundary between the display area for the active data processing system and an adjacent display area for another data processing system. If not, the process proceeds to step 310, which depicts maintaining the cursor location at the display area boundary, with the cursor location along a different coordinate axis (parallel to the display area boundary) and the cursor display image within the display area being updated if necessary I.e., the cursor movement was along both coordinate axes).

If movement of the cursor crosses a common boundary between two display areas, the process proceeds instead from step 308 to step 312, which illustrates the active data processing system to which input signals are transmitted from the data processing system corresponding to the original display area in which the cursor was depicted to the data processing system corresponding to the adjoining display area into which the cursor was moved. The process next passes to step 314, which depicts setting the cursor

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location within the new display area based on the cursor movement detected, which will result in the cursor image within the new display area being displayed at a corresponding location past the common boundary. The process then passes to step 316, which illustrates the process becoming idle until cursor movement is again detected.

The present invention allows input devices shared between data processing systems to be automatically switched based on a logical arrangement of display areas to form common boundaries and movement of a pointer-driven cursor past a common boundary. Manual, physical switching of the active data processing system receiving input signals from the common input devices is not required. Hot key switching by the user is also not required, together with knowledge of the logical arrangement of the data processing systems within a switching sequence when the logical display areas are arrangement to correspond to the positions of the physical displays.

It is important to note that while the present invention has been described in the context of a fully functional data processing system and/or network, those skilled in the art will appreciate that the mechanism of the present invention is capable of being distributed in the form of a computer usable medium of instructions in a variety of forms, and that the present invention applies equally regardless of the particular type of signal bearing medium used to actually carry out the distribution.

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Examples of computer usable mediums include: nonvolatile,  
hard-coded type mediums such as read only memories (ROMs) or  
erasable, electrically programmable read only memories  
(EEPROMs), recordable type mediums such as floppy disks,  
5 hard disk drives and CD-ROMs, and transmission type mediums  
such as digital and analog communication links.

While the invention has been particularly shown and  
described with reference to a preferred embodiment, it will  
10 be understood by those skilled in the art that various  
changes in form and detail may be made therein without  
departing from the spirit and scope of the invention.